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THE GLASS INDUSTRY

VOLUME 18, NUMBER 9, SEPTEMBER 1937

# GLASS SANDS

By W. R. SCHOLES

Silica makes up about three-fifths of the rocks of the earth. A good deal of it is combined in the silicate minerals. Perhaps one-third of it is actual free silica or quartz, but a great deal of this quartz consists of crystals in such rocks as granite or pegmatite, from which it can scarcely be separated. Other vast quantities of quartz may be found in the sands of the seashore, or of sandy soils, or river beds, or sand pits, so mingled with other minerals and so impure that no amount of work could ever separate pure silica from the mixture.

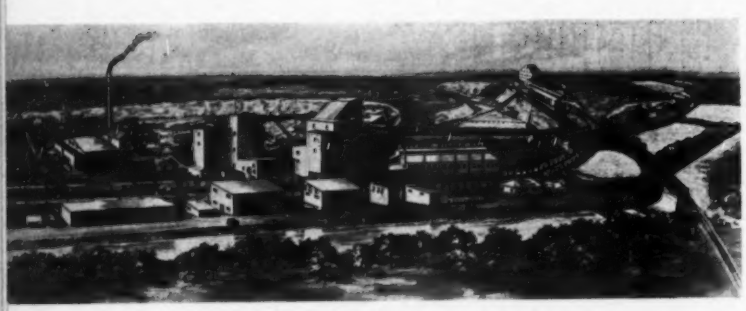
The glassmaker is interested in quartz of a high degree of purity, and he is also particular about the size of the individual grains. Accordingly, for a source for this fundamental raw material, he must depend upon natural deposits in which the forces of nature have placed quartz in such a state of purity that a reasonable amount of well-directed effort can deliver it to the glass house in desirable form.

The United States is fortunate in the possession of many deposits of silica suitable for glassware. From the point of view of geography this remark is trite, for the reason that any portion of the land area of the earth so extensive as our own country can scarcely help having many deposits of reasonably pure quartz. If we limit the above general statement by saying that a number of these excellent deposits are favorably located with respect to the fuel supplies and other advantages which determine the location of glass factories, we shall show this natural advantage in a better light. However, some of the American sand rocks have aroused the admiration of the Europeans, and are cited in foreign works on the subject as among the purest deposits of silica available in the civilized world.

Modern glass sand is practically a chemically pure reagent. It contains, in general, only one impurity that is really undesirable, and gives the glassmaker any trouble. This impurity is iron, which may be present as fine metallic rubbings from the grinding and handling equipment, as the rusty particles resulting from exposure of these iron rubbings, as any of the iron minerals—hematite, magnetite, limonite, ilmenite, or as some of the silicate minerals, in which iron is present as a major or minor constituent; for example, garnet or mica. Hence the specifications for a sand emphasize particularly the total iron content, expressed for convenience and accuracy in terms of $Fe_2O_3$. Other impurities are important, in general, only because their presence reduces the available quantity of silica itself. A sand containing, for example, a few per cent of alumina might be even more valuable for some purposes than a sand virtually free from alumina. But for glasses where alumina is not to be introduced such a sand would be altogether wrong. Moreover, the glassmaker would need to be assured of constancy in the alumina content, and he would need to be able to calculate correctly how much of this secondary ingredient was being brought in with his sand. A similar remark would apply to lime which might be present in a sand either as calcium carbonate or a mixture of calcium and magnesium carbonates. Although these minor ingredients, so far as they consist of a colorless earth which would ordinarily be put into the glass anyway, might well be permitted in the sand, glassmakers have rightly preferred not to be bothered with their adventitious presence, but rather to be able to rely upon the sand as practically 100 per cent silica and to put in all the other ingredients in the form of other proper raw materials.

Specifications for glass sand can be drawn up partly with a view to what the glassmaker actually needs, and partly as a simple description of what can be had. When No. 1 glass sand is purchased we expect to get not less than 99.5 per cent $SiO_2$, not more than 0.3 per cent $Al_2O_3$, less than 0.1 per cent CaO and MgO, and less than 0.025 per cent $Fe_2O_3$. Moisture will be negligible, and any other oxides than the ones mentioned above will be found only in traces. The grains will all be small enough to pass a 20-mesh screen. At the other end of the screen analysis a rather wide variety of fineness will be found. Some sands will practically all be retained upon a 70-mesh screen. Others will have an appreciable quantity passing 70-mesh, and even 1 per cent or thereabout passing 100-mesh. The practical glassmaker finds very little difference in the melting behavior of these sands and will scarcely argue for the rigid inclusion of screen analysis in his specifications.

The permissible iron content must naturally depend upon the character, more precisely the "color," of the glass which is to be produced. In optical glass this should be at the real minimum consistent with quantity production of sand. This can be set perhaps at 0.015 per cent. For fine crystal, the same ideal is present; but good decolorizing can be accomplished with an iron content in the sand as high as 0.030. For bottles a wider range exists, because we are concerned not only with



● *The plant of the Ottawa Silica Company, Ottawa, Illinois.*

● *Pennsylvania Glass Sand Company, Mapleton, Penna.*

● *Aerial view of the Millwood Sand Company, Zanesville, Ohio.*

crystal bottles for perfumes, and decorative bottles, fine prescription ware, but with the countless varieties used for beverages and reagents, and the light green bottles for acids and finally the definitely green or amber bottles for all sorts of purposes. For these and similar wares, in which color ceases to be important, the iron content of the sand becomes a matter of indifference; but it must be remarked that the glassmaker would usually rather put in his own iron in definite quantity if he desires a green product than to have an impure sand with a variable iron content which may often be accompanied by a variable alumina content. A similar remark applies to flat glass, in which the presence of a relatively high amount of iron oxide may become quite inconspicuous, because of the relatively thin layer of glass viewed. It is fair to remark that the same series of operations must be applied to the preparation of sand whether or not it is made from a deposit of high purity. Likewise in a single factory a number of grades of glass may be made; and, rather than bother with sand of several qualities, the glassmaker may reasonably prefer to have one sand of high purity suitable for crystal, and then introduce the iron oxide as such wherever green color or light-stopping is actually indicated.

Some uncertainty attaches to the estimation of the iron content of sand. This uncertainty arises from the difficulty of sampling. Whether the chemist uses a one-gram or a ten-gram sample, this quantity is still ridiculously small as compared with a carload. However carefully the sample may be taken or whatever pains may be exercised, in dipping up the sand and in the quartering down to sample size, the chemist may, at one time, get an exceptionally pure sample; or he may, at another time, finally treat a portion containing an accidental scale or bit of rust which may give him a result altogether out of line with the real state of affairs. These unavoidable accidents of sampling account for the wide variation in the iron contents reported by different analysts on sand from the same source and treatment.

Quartz crystals originating from the magmas of this once molten globe have become separated from other minerals with which they were associated in igneous rocks such as granite, because they have resisted disintegration and abrasion. These other minerals; for example, the feldspars and micas, have decomposed by weathering through the long processes of geological time and have washed away as silts and clays, leaving the quartz grains to be transported and deposited by somewhat similar means but at a different rate. Occasionally the action of wind seems to have caused these grains to roll and drift until their original sharp corners were rounded off. Some of this silica has been water-borne; sometimes lime has been carried into the mass by water containing carbon dioxide and has consolidated the material into a rock by means of a calcareous cement. But the sandstones in which the producer of glass sand is interested are those which have been cemented together by silica itself, brought into a soluble form or silicic acid by reason of its limited, but nevertheless real, solubility in water. Burial at considerable depths as a result of the convulsions that have occurred on the earth's surface, and consequent subjection to heat and pressure have further consolidated these sandstones into more or less hard rocks. Some of these rocks still lie well beneath the surface, and are brought up by drills boring for oil or gas at depths of thousands of feet. At other locations these rocks have been again thrust to the surface by later upheavals and made available for quarrying.

When these rocks are very hard they are called quartzites. The variety known as the Oriskany, outcropping throughout the Appalachians, has become the important source of glass sand in the eastern part of the country. When consolidation has been more lightly accomplished, the rock is called a sandstone. The typical variety, St. Peter sandstone, is found in a state of high purity in Illinois and Missouri, and becomes the important source

for glass sand in the Mississippi valley. These terms are relative, and all degrees of consolidation may be found. However, there is a wide difference in the two rocks specifically mentioned. The Oriskany is a definitely hard rock, which can be disintegrated only by mechanical means, whereas the St. Peter is so soft that it disintegrates under the action of water alone. This fundamental difference in the tenacity of these two rocks determines the specific processes which are applied in the production of glass sand in the two regions mentioned.

In addition to these deposits of quartzite and sandstone, there are unconsolidated sands occurring in many scattered localities which are occasionally of sufficient purity and high silica content to be suitable for glass-making. Among these should be mentioned particularly the sands of South Jersey, which were among the first deposits to be worked in the United States, and which are still supplying sand for local manufacturers. Other deposits were worked in the Berkshire hills of Massachuset's from which a small quantity of sand is still being supplied. In colonial times, when the glass furnaces were still burning wood, and before suitable machinery could have been built to cope with harder rocks, these bank sands, susceptible to simple hydraulic treatment, supplied the early American industry. They are now of local rather than of national or general interest. Outcroppings of Oriskany quartzite are conspicuous in the Alleghany ridges of central Pennsylvania and also in the mountains of West Virginia and Virginia. Tumbled heaps of huge boulders of this material, sometimes called "ganister flows," may be seen decorating the slopes of these mountains at many points, and here and there are cliffs consisting of tilted beds of quartzite sometimes standing up at a steep angle. The selection of one of these cliffs for quarrying depends upon a number of considerations. Fundamentally, the rock must be reasonably pure silica. Next, it must not be too tenacious. Some of the ganister is so very hard and fine-grained that it is suitable only for silica-brick manufacture or for road material. An abundant and reliable water supply must be at hand. Transportation is a very important factor; and the location must be chosen with regard to supply of power, and as a lesser consideration, a supply of labor.

The workable deposits usually have very little overburden. Horizontal drilling into the cliff face, followed by blasting breaks down a quantity of rock, and usually releases the large overlying masses which slip at the seams or bedding planes between strata, from quarry faces 60-200 feet in height. The more or less shattered material—sand, lumps, and boulders—is picked up by a power shovel and loaded into trucks for transportation to the jaw crusher. Ten tons at a time may be dropped into the cavernous mouth of the crusher, which will handle rocks up to four feet in diameter. In less than a minute this charge has been reduced so that it will pass through the six-inch opening at the bottom. 200 H.P., giving a swing of an inch or two to the movable jaw of the crusher at its lower edge, applies an irresistible bite that cannot fail to smash the rock so that it can be handled by the next reduction unit.

The material falls from the jaw crusher upon a rubber belt which conveys it by way of a revolving steel "grizzly" to a conical crusher something like a tremendous iron mortar. Through the grizzly, as through the conical crusher, passes material of fist-size and smaller to another rubber belt carrying feed for the chaser mills or wet-pan grinders. The steel-tired wheels of the chaser mill, each wheel some four feet in diameter, with a 10-inch thickness, carried on a 7-foot axle, travel over a

● *The sand pit.*

● *Hauling sand to the primary crusher building.*

● *Typical quarry drilling operation.*

relatively thick layer of the rock, to which has now been added a copious supply of water.

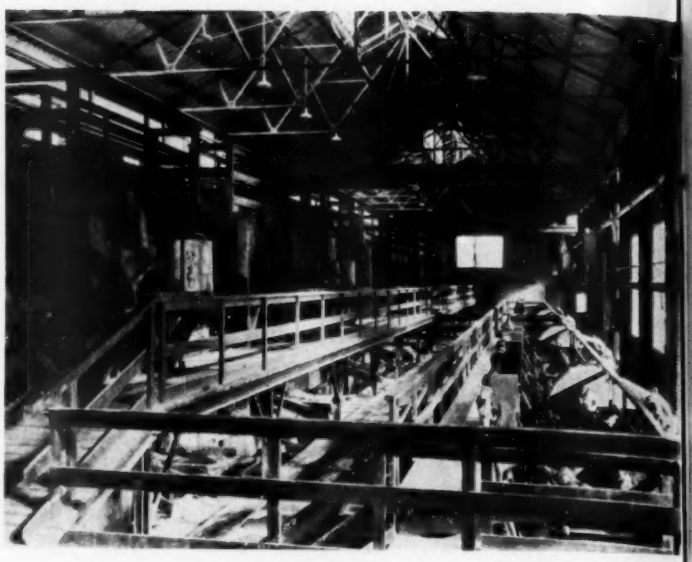
Part of the slanting side of the wet pan is punctured with 3/8-inch holes through which the crushed material escapes. The wet slurry of sand, fines, and incompletely crushed rock is led onto a vibrating screen, through which the sand and fines are carried by the water to the washers. The tailings pass over the screen and a water lift returns them to the chaser mill. This reduction operation is intentionally swift. In order that there may be no actual crushing of sand grains the crushed product is removed from the mill very quickly before it has had time to encounter too many passages of the crushing wheels. Likewise, close contact between the steel tires and the hardened plates of the pan bottom is avoided by rather rapid feeding, which maintains a layer of quartzite several inches thick between the wheels and the pan, and reduces to a minimum the wear of the steel crushing members and the consequent introduction of iron particles into the product.

Washing is accomplished by carrying the sand mechanically through an inclined trough against a stream of water. In the Lewistown washer, this trough is practically square in cross-section and in it revolves an Archimedes screw forcing the sand upstream. From the top of the first of these troughs the wet sand flows down a chute to the bottom of a second washing effect, and the operation is repeated twice more. The water leaving the first washer carries a heavy load of loam, vegetable detritus, and fines present in the sand as originally crushed. The second wash water is much less clouded, and the water leaving the fourth effect is practically clear. It is obvious that a sufficiently swift stream of wash water would not only carry away the undesirable earthy material and organic impurity but would result in wasting a considerable portion of the finer sand. Careful judgment must be exercised at this point in order that the proper washing may be accomplished without loss of product.

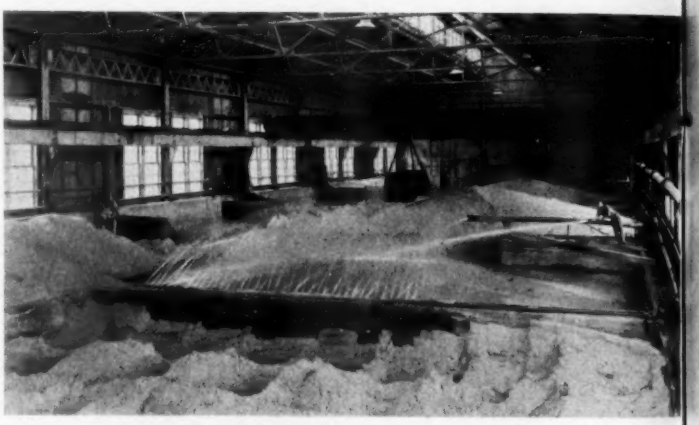
A new washing device has lately been developed at one of the Pennsylvania plants in which a series of paddles with a slightly elliptical reciprocating movement thrust the sand up-stream. This type of washer is very effective, because it keeps the sand suspended as a slurry through most of the operation. There is also less sliding of the sand against steel blades, and the bearings of the device are all above water.

From the top end of the washers the soaking wet sand, containing about 25 per cent water, is pushed out upon a rubber belt which conveys it to the drainage shed. Here thousands of tons of damp sand may be stored while the water drains away and escapes through the porous floor, so that only a minimum of moisture will be present in the sand when introduced into the dryers.

A clam-shell bucket on a traveling crane conveys the damp sand to a long, rectangular, brick bin, at the bottom of which are pipes carrying steam under pressure. These pipes, running lengthwise, are arranged in layers successively closer and closer together, and the sand, as it loses its water and becomes free-flowing, can trickle through between the close-laid pipes of the bottom layer and emerge as hot, dry sand on the conveyor belt passing underneath. The clean, white, dry product goes on over a magnetic pulley for the removal of traces of magnetic iron, through a final screening operation, and is then conveyed to tall, concrete storage bins.



● *The reduction and washing process.*



● *The second washing. The sand is then stored in drain bins, prior to placing on dryers (shown at the left).*

Up to the present time, since no special type of freight car has been provided for sand shipment, it has been loaded into ordinary tight box cars lined with Kraft paper against leakage of the sand. Loading was formerly accomplished by allowing the sand to flow from the storage bin, through a chute, into the center of the car, from which point it was shoveled into the ends of the car to level off the load. An improvement upon this operation consisted in a short conveyor-belt assembly inclined at about a 45°-angle. As the stream of sand falls upon this rapidly moving belt it is thrown toward one end of the car; and when a suitable heap has accumulated, the position of the throwing belt is reversed to load the opposite end of the car. Finally, the portable belt and its drive are removed and the center of the car is loaded directly from the chute. Meanwhile a powerful exhaust fan carries away the dust through a large pipe at the opposite door of the car to a separating system.

A new type of freight car, especially designed for the

handling of sand, will soon make its appearance. This car will be loaded directly through doors in its low roof, and upon arrival at the glass plant, will be unloaded by tapping directly from the bottom. This car will be welcomed, not only by the shippers, but by the receivers of sand, because it will eliminate so much of the labor and inconvenience necessary in getting the product into and out of the poorly-adapted box car.

The processing of the St. Peter sandstone offers a simpler and quite different problem. Here the rock is attacked in a quarry pit rather than from a cliff face, although the quarry wall may at times have a height of 60 feet. Blasting is carried out in a series of vertical drill holes put down a few feet from the face. As the shattered rock falls to the quarry floor it is attacked by a high-pressure, high-velocity stream of water which disintegrates it and carries the material to a sump, from which centrifugal pumps force it through rubber-lined pipes to the washing plant.

With this sand it is customary to use a tank system of washing in which the sand is whirled through a series of tanks by the use of large volumes of water, and finally emerges to pass through the same type of drying operation previously described.

Inasmuch as no crushing or grinding has been done, the dry product contains grains of all sizes from fines up to nearly $\frac{1}{8}$ inch in diameter. An elaborate system of vibrating screens separates the sand into a number of products of which glass sand, although it represents the bulk of the material, is only one.

In the production of sand from unconsolidated deposits, the method in use is entirely hydraulic. Very often the separation of iron minerals and other undesirable constituents is accomplished on a flat classifying table which takes advantage of the respective different specific gravities of the sand and the impurities in delivering a stream of relatively pure material before the final washing process. Sand production of this sort is purely local in character, and is hardly a factor in the industry as a whole.

In certain plants, particularly near Zanesville, Ohio, a sand, produced from a somewhat inferior rock, is treated with hot, concentrated sulfuric acid for the removal of iron oxide. This expedient results in a great improvement in the quality of the sand, making it available for varieties of glassware for which it would be entirely unsuited in its original condition after simple washing.

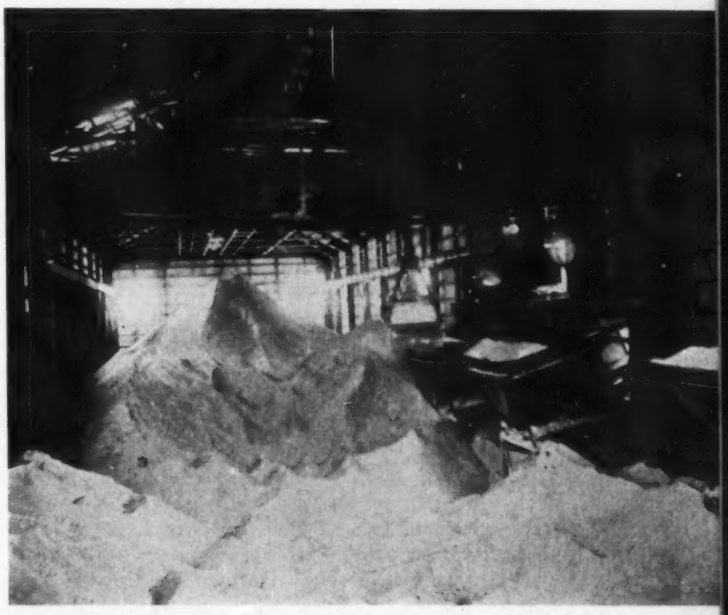
Some excellent sand is being produced in southern Michigan. Its undesirable feature is that it carries a variable proportion of dolomitic limestone particles. These would not be undesirable, as such, if the proportion present in successive lots of the sand remained constant.

Although most glass sand production starts with open workings, some of it is actually mined; as in Missouri, where some of the loosely consolidated sand is found with such a deep overburden that the ordinary quarrying operations cannot be applied.

When glass sand from different sources is viewed under a microscope or even when the grains are rubbed between thumb and fingers it becomes apparent that they have different shapes. The Oriskany quartzite is broken down by crushing to grains which are definitely sharp and angular, while the grains from the St. Peter sandstone, presumably blown about by the winds of past ages, are quite smoothly rounded. In all of the best glass sands, the bulk of the material will be found upon screen analysis to pass through 30- and be caught upon 50-mesh sieves.

Although the production of glass sand is not one of the country's major industries, it is one of vital importance to glass manufacturing and to the whole field of ceramics. Potter's flint is glass sand which has been ground in tube mills by flint pebbles to 200-mesh fineness. Sand-blast sand and molding sand are practically by-products of the major industry. Grinding sand for

(*Continued on page* 307)



● *Damp sand storage.*

● *Preparing for the drying process.*

# TROUBLE SHOOTING AND THE PENETRATION FACTOR

By GEORGE ROESSLER

• *This article is the third of a series on mold design. It reviews some of the difficulties commonly encountered and, based on the theory of "ductility" previously discussed, the corrective remedies. The Editor.*

The philosophy of trouble shooting in the hot end, as in the whole field of industrial endeavor, resides largely in establishing uniformity. Hit-or-miss results preclude the application of correctives, for the obvious and inherent reason that the origin of the error cannot be captured. Even as difficulties obtrude themselves without notice and in the most unexpected places, so also and in a like manner will be found the solutions. Perfection, if such a condition exists, is ultimately attained by the process of elimination. In the fabricating of glassware, the ductility of molten glass and the penetration factor supply a simplified technology by which the erratic and seemingly mysterious behavior of the glass in the mold can be governed with a reasonable degree of certainty.

The practice, in designing blank molds, is to calculate the cavity of a size or volume which is in a certain ratio to the volume of the solid mass of glass; to lay out the length of the parison so as to allow for the stretch and sag during the interval of transfer; and to make the various cross-sectional contours in proportion, roughly, to the corresponding cross-sections of the finish mold. It has always been the belief that if the proportion is correct the glass, at the blow-back, will be distributed uniformly over the surface of the cavity. It has also been the belief that if the distribution in the blank is not correct then the ratio is not correct and the blank molds are sent to the mold shop to be "whittled." Sometimes the brunt of the whittling falls upon the plunger.

It must be remembered that the glass is in contact with the iron while the finish is being made and penetration takes place, and then the hot, inner area of the glass is blown back. The parison, therefore, is comparatively cold at the shoulder, but very hot at the bottom end, since it is made of the hot, inner glass. To all appearances this differential of temperature is not excessive; but and this is important—the differential in ductility is pronounced. In the lower range of working temperatures of glass slight changes of temperature make decided changes in the ductility. Therefore, the parison must be designed for size and proportions so as to compensate for these variations in ductility.

What is needed is a provable set of ideas by which the glass of the parison can be controlled in its relative disposition—light at one place and heavy at another, according to a foreseen requirement. Controlling the ductility characteristic of melted glass, through a control of the penetration factor, is the means by which this can be done.

To describe best the application of the penetration theory to the matter of shooting trouble, a few of the more common difficulties will be discussed, together with the several principles involved. Some of these trouble cases will come under the class of operating errors and some will be errors of design.

Heel-tapping almost invariably originates in the blank at the time of the blow-back. One of the chief reasons is because the heat of the molds is being dissipated by a wind blast on the inside of the mold while it is in the open position. Wind blast or "wind" is the only way provided by present equipment for dissipating the increment of heat imparted to the mold by the hot glass. When this wind is directed to the inside of the mold in the open position, the four edges or corners of the cavity which make the joint line when closed, are cooled to

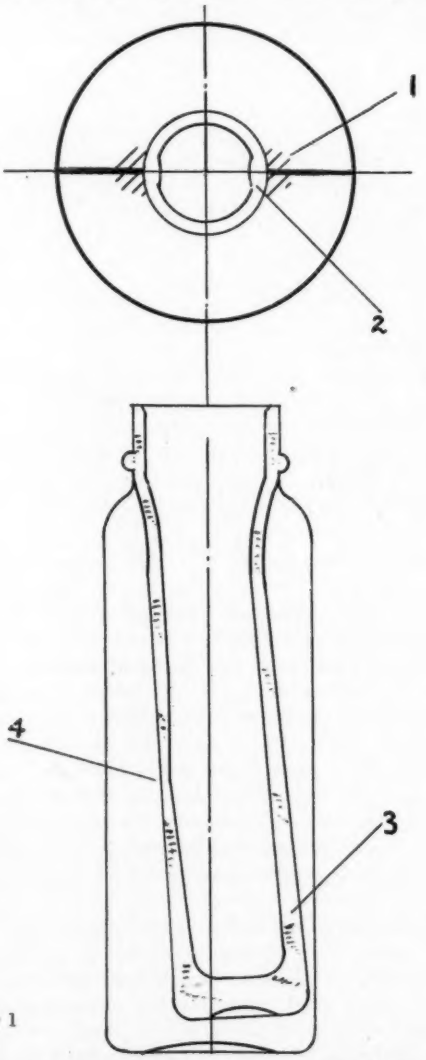



*Figure* 1

lower temperatures than the rest of the mold, with the result that, at the blow-back, two cords of deeper penetration or less ductile glass are formed at the joints and oppositely disposed. While not visible, the cords are, nevertheless, present and are never exactly alike for penetration or ductility. When the blank is transferred and blown in the finish mold the weaker cord parts or stretches faster than the heavy one and the blank is bent to one side. The instant the distorted blank touches the iron of the finish mold it is frozen and the weaker side continues to stretch, with the result that an excess of glass is left on the side which touched first.

In Fig. 1 is illustrated a sectional view of a mold with the corner areas shaded, at (1), to indicate that they are relatively cool, and at (2) are shown the cords which are formed as a result of deeper penetration. At (3) is shown how the blank will bend to the side when blown in the finish mold. The break at (4) illustrates how the weaker cord will part and stretch. This is a very common error and is the responsibility of the operator of the machine. Wind should seldom be played on the inside of the blank mold when open. Care must always be taken to obtain uniformity of heat dissipation.

In Fig. 2 is illustrated the upper portion of an export beer bottle. The error to be corrected is the excessive wall thickness in the bulbous neck as shown at (1). A glance at this sketch shows that the blank mold is running cold in the neck with too much penetration at the time of the blow-down. The first correction to apply is the timing of the blow-back. This should be moved up so that the duration of penetration is reduced. If this

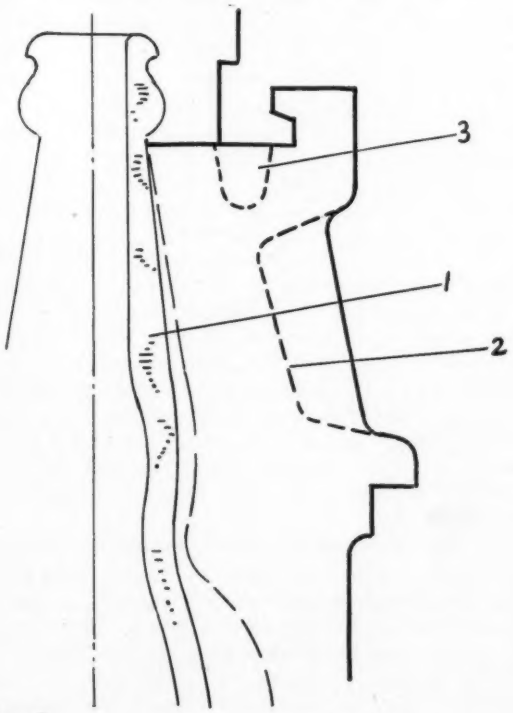



*Figure 2*

does not lighten the neck enough, the machine may be speeded up a little; but then more wind must be used on the bottom of the blank to balance the additional increment of heat. In case the combination of these two

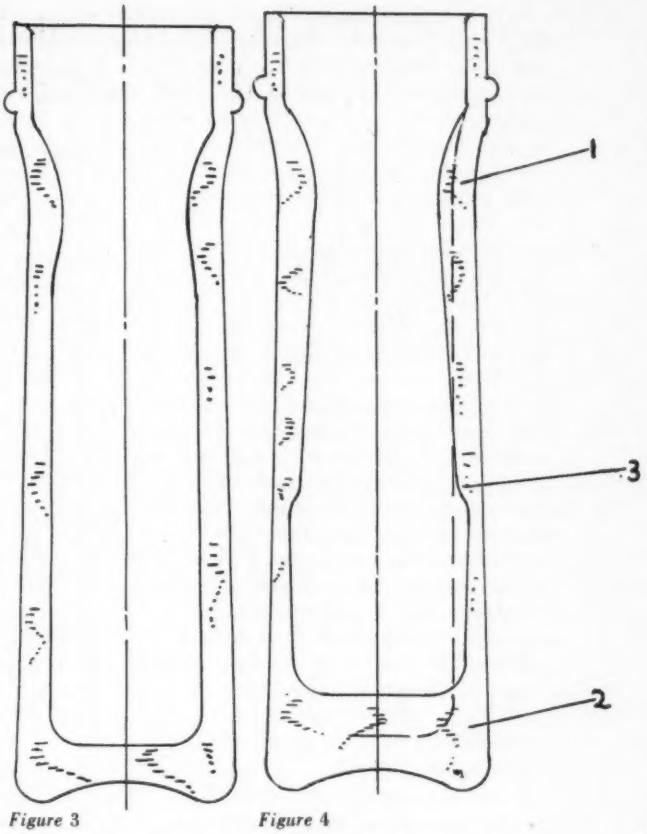



*Figure 3* *Figure 4*

does not give the desired result then the molds are too heavy and they should be taken off, one at a time, and turned off in a lathe as shown at (2). To reduce further the penetration factor directly under the finish it may be advisable to score the face of the mold as shown at (3). All of this, however, will be effective only if the ratio is approximately correct. On the other hand, these changes, each or in combination, should be sufficient to obtain the desired correction when the chosen blank ratio and the calculations are about right. The temperature of the glass being delivered by the feeder is an important item, as is also, the speed of the blow-back. The manner of their usefulness is self-explanatory after all that has been set forth.

In Fig. 3 is shown a blank for an olive bottle and the "trouble case" is the one of heavy shoulders and light bottoms. As would appear from this sketch, the penetration is excessive in the shoulder, and by reducing this, the glass will be distributed throughout the rest of the blank form. Note in the sketch that distribution is good at every place except the shoulder. Proceed, as outlined in the text for Fig. 2, to reduce the penetration where the glass is heavy. If the mold is cored, as has been previously described, there should be no difficulty in correcting this trouble. If the mold is not cored then the resourcefulness of the moldmaker will be called upon to find a way to lighten the molds in order to get the desired result. It must be remembered that it is the depth of penetration which is the measure of controllability. Thinking in terms of penetration facilitates the solution to these problems, under the conditions of heat and confusion in the factory.

In Fig. 4 is illustrated a blank for an olive bottle and the trouble case is the compound one of heavy shoulders and heavy bottoms. The heavy shoulder is at (1), the heavy bottom at (2), and a "high-water mark" at (3). At first glance the corrections for these appear to be opposed to each other, but this is not the case, as will be shown. First, the heavy shoulders should be corrected by any one or all of the methods heretofore described. This will throw the glass to the bottom and thus simplify the case. Proceed then, in the order named, to slow down the speed of the blow-back, increase the dissipation of heat at the bottom of the mold, run the machine slower in order that the molds will work colder, etc. When this has been done and a permissible quality of ware has been attained, it may be found that production is not up to the required standard. This is because the molds are generally too light in weight, particularly in the bottom. They will have to be replaced with a new and heavier set. Therefore, blank molds should always be made with an excess of weight at the bottom.

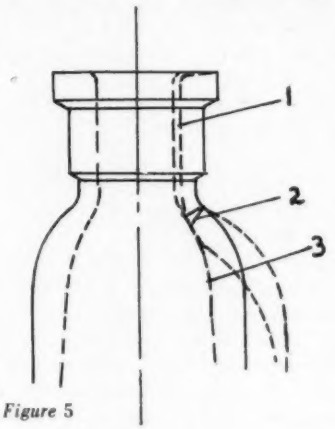


*Figure* 5

A case of finish trouble is shown in Fig. 5. The example is the well-known Lysol bottle, having a finish which is exceptionally heavy and difficult to "freeze." The job can best be made on the Mod. 10 machine if the blanks and machine operation are capably engineered. The neck rings on Mod. 10 machine run colder than on other equipment, thus furnishing an asset as regards heavy finishes. The trouble, in this case, is that the inside of the finish or corkage pulls downward and is distorted at the final blow. Due to the shape of the bottle, the appropriate blank form is one which inherently runs cold in the shoulder, thus causing an excess of penetration at that place and providing a heavy shoulder for the final blow in the finish mold. The distortion of the corkage is shown at (1) and the heavy shoulder at (2). At final blow, therefore, the heavy shoulder acts as a lever to pull the glass of the finish downward, since temperature and ductility of the glass in the shoulder and finish are about the same. The lever action is shown at (3). The correction is to obtain a ductility differential between the finish and shoulder by running the finish as cold as possible and the shoulder hot. The blank mold should be cored at the shoulder to obtain this differential.

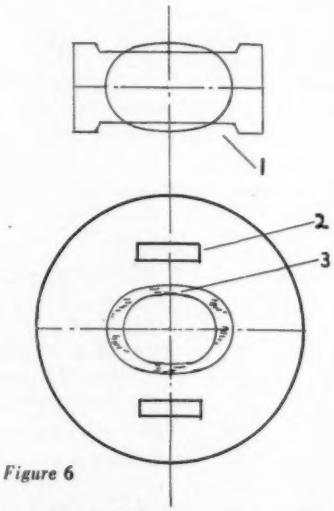


*Figure* 6

In Fig. 6 is shown the exceptional case of the panel extract, wherein the blank is made substantially out of proportion to the blow mold for the practical purpose of having a blank cavity which will receive the falling gob of glass. This is known as a "squeezed blank." The squeezing takes place in the blow mold. The glass touches at the sides in advance and penetrates deeply to form pronounced saddles in the ware. As an aid to reducing these saddles the distribution in the blank is made to run light at the sides. This is accomplished by placing vertical cones along the side of the cavity and near enough to cause a peneration of minimum proportions.

In Fig. 6, a diagrammatic view (1) shows the cross-section of the mold and blank superposed to show the dissimilarity of proportions. At (2) are the vertical cones and at (3) the lighter wall of glass due to the lighter penetration.

Many examples could be presented, but such an expression of the subject would be mere repetition—an elaboration of the principles set forth. The ductility of the glass is controlled by the temperature and this, in turn, by the penetration factor, in manifold ways and according to the understanding and ingenuity of those responsible. Every company should accumulate a file of case histories, not so much to preserve the ingenious aspects of the corrective as to have for ready reference a record of the quantitative features. In any case, the problem is one of attaining a sensitive tune-up of the various functions which have been explained.

Designers and operators can take good cheer, since the pioneering in this field has been done. The goal of endeavor now is to make better ware — lighter and stronger, and free from sinks and deformations.

Finally, the production of glassware is only one step in the overall business of packaging, boxing, selling and delivering the many products of consumption. Therefore, it is a matter of great importance to make it of high perfection in order that it will fit the varied requirements with precision and effectiveness. There has been almost unbelievable progress in the manufacture of glass, and all of this has come about by minute attention to such details as have been recorded in this article. One improvement points the way to another.

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The glass container industry will require 2,785 freight cars for the third quarter of 1937, according to an estimate by the Glass Container Association. This is 20 per cent more than the corresponding period of last year.

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Thirty-five per cent of all beer produced since repeal has been sold in packages, reports the United Brewers Industrial Foundation. Up to August 10, 1937, this packaged beer is estimated to have contributed one billion dollars in federal taxes. Shipments of new beer bottles totaled 1,848,000 gross for the first five months of 1937.

● *Samuel B. Bowman.*

## DEATH TAKES HAZEL-ATLAS EXECUTIVE

Samuel B. Bowman, Factories Manager of the Hazel-Atlas Glass Co., died at Johns-Hopkins Hospital, Baltimore, on July 30th. His death followed an illness of several months, but the serious nature of his malady was not realized until recently. Funeral services were held on Monday, August 2nd, in Zanesville, Ohio, where Mr. Bowman had resided since 1924. Born in Allentown, N. Y., May 20, 1884, Mr. Bowman entered the employ of Hazel-Atlas in 1906, after graduation from Washington and Jefferson College. He served the company in various capacities in the following years and was made manager of the Ohio-Oklahoma District in 1924. In February, 1934, Mr. Bowman was made general factories manager of the entire Hazel-Atlas organization, comprising thirteen plants. He is survived by his wife, his mother, a sister, five daughters and two sons. Prominent in the church and social life of his home city and a leader in its industrial affairs, Mr. Bowman also leaves a host of friends throughout the glass world, all of whom will miss his warm personality and thoughtful counsel.

## THE BELGIAN GLASS INDUSTRY

*Plate Glass:* A slackening in activity. Exports to Japan particularly hard hit, due to new Japanese mills coming into production. Depreciated German currency has resulted in a diversion of trade to that country.

*Window Glass:* Orders have declined 50 per cent in 3 months.

*Table Ware:* Demand satisfactory, output slightly up. Several mills, however, are still idle.

*Containers:* Unfavorable weather has prevented normal seasonal activity from materializing.

## GLASS NEWS FROM JAPAN

The latest to enter the glass field is the Showa Plate Glass Company, Limited, which was established in Tokyo on June 9 with a capital of 5,000,000 yen ($1,440,000). The company has been promoted by Mr. T. Takahashi (Showa Rayon), the Aji-no-Moto Foodstuff Company, the Ishii Iron Works, C. Itoh & Co., the Katakura Silk Reeling Company and other major stockholders. The factory is expected to be put in operation about September 1, with an estimated annual capacity of 240,000 cases. A second factory is to be built at Kawasaki before March, the proposed output there being 480,000 cases annually. A third plant is to be located either at Nagoya or Jinsen, Korea, with a capacity of 240,000 cases.

What rolling process will be employed is at present a matter of conjecture. Many experts believe that it will be difficult for the new firm to get a license to operate one of the leading systems and that therefore the plant will be hardly ready for operation as scheduled. No satisfactory sheet and plate glass machinery is made in Japan. On the other hand, Fourcault and Pittsburgh are monopolized by the Asahi Glass Company of Mitsubishi affiliation, while Colburns is tied up with the Nippon Sheet Glass Company. Reports have it that the Showa people have in turn been rejected by Libbey-Owens-Ford, and Bicheroux, and that the German Bach system is likely to be adopted.

The new plate glass enterprise of the Kawaminami Kogyo, which is now building a plant at Saga, Kyushu Island, is designed to produce 30,000 tons of soda ash and 360,000 cases of plate glass a year. Plate glass output is to be stepped up to 1,080,000 cases.

### Glass Wool

Toa Sangyo K.K. (East Asiatic Industry, Limited) engaged in the mining and refining of silicate sand, will soon manufacture glass wool on a large scale.

### New Plate Glass Enterprise in Formosa

Taiwan (Formosa) Chemical Industry, a subsidiary of the Nissan combine, plans to establish a large-scale plate glass plant at Chikuto, Shinchikusho, Formosa. Natural gas abounds at this locality.

### Overproduction?

Indications are that overproduction is bound to become a pronounced feature of Japan's plate glass industry. The output of the two leading concerns, the Asahi and the Nippon Sheet Glass combined stands at present at 6-7 million cases for the current year. Smaller companies supply another 2 million cases. When the various new projects that have been reported on in these columns have entered the stage of actual operation, Japan's capacity will be in the neighborhood of 10 million cases in the near future. The increasing overproduction will have to be met by exports. As a rule of thumb, it may be said that the output of the smaller companies is entirely sufficient to meet the domestic demand, while the volume of the two large concerns constitutes the quantity available for export. Naturally each new factory adds to the excess production, which has to be disposed of in overseas markets.

### Further Expansion of Asahi Glass

The Asahi Glass Company has attained a total productive capacity of 4,420,000 cases annually for various grades of glass. Annual capacities for its various products as of May 1 follow:

| | |
|---|---|
| Sheet and plate glass | 4,100,000 cases |
| Figured glass | 200,000 cases |
| Wire glass | 80,000 cases |
| Polished glass | 40,000 cases |
| Corhart refractory materials | 4,000 tons |
| Fire brick | 20,000 tons |
| Soda ash | 350,000 tons |
| Caustic soda | 100,000 tons |
| Sodium bicarbonate | 23,000 tons |
| Calcium chloride | 20,000 tons |

Japanese production of plate glass in January was 377,118 cases, comparing with 324,157 cases turned out the preceding month.

The Nisso "Konzern," whose mushroom growth has been attracting widespread attention, will soon go into glass making. This will be done by the Second Kyushu Soda Company, a 10,000,000-yen subsidiary of the Nippon Soda ("Nisso" for short). The Second Kyushu will most likely be merged with the First Kyushu Soda, a 15,000,000-yen concern, in which "Nisso" has a 27 per cent interest. This company has already been turning out various kinds of plate glass the past few months.

### Susceptible to High Blood Pressure

An investigation by the Health Bureau of the Osaka Prefectural Government has brought to light the interesting fact that the Tokunaga Glass Works, Limited, a concern with 421 operatives, has the greatest number of high blood pressure cases among all industrial plants under the jurisdiction of the prefecture. Declares Mr. Yagi, industrial health expert of the office, "This is due chiefly to the high temperature prevailing in glass plants. I am also convinced that night operations are partly responsible for this phenomenon, which has also been observed in other Japanese glass factories."

### "UV" Glass Passes Ultraviolet Light

Declared to be capable of passing through ultraviolet rays with a loss of no more than 10 per cent, "UV" glass has been put on the market by the UV Glass Company, Limited, of Tokyo.

The product is offered in three grades, each being subdivided into A and B, according to the perviousness to ultraviolet light. The glass ranges in thickness from 1 to 5 mm. The first grade affords passage to more than 90 per cent of the ultraviolet rays; the second grade passes through more than 80 per cent; the third grade, less than 75 per cent.

Grade A ranges in price from Y0.50 to 0.65 per square sun (1 "sun" equals 30.3 mm and is approximately 0.10 ft.).

### I. E. S. CONVENTION PROGRAM

The Illuminating Engineering Society will hold its annual meeting at The Greenbrier Hotel, White Sulphur Springs, W. Va., September 27 to 30. Concurrently with the meeting, the National Lighting Sales Conference will be held on Monday and Wednesday of those dates, under the auspices of the I. E. S. Committee on Lighting Service. There will also be a Residence Lighting Forum on Wednesday. Among several papers of general interest to glassmen, one in particular, "Artificial Illumination of Glass Blocks," by C. S. Woodside, Westinghouse Lamp Division, will treat of a comparatively new development. The convention committee has also planned what it describes as "a most spectacular and unusual presentation of outdoor illumination, using new types of light sources, which will offer opportunity for a study of future possibilities in this direction."

No sessions are planned for Tuesday and Wednesday afternoon, to allow time for sports and recreation. Special entertainment will be provided for the ladies, and there will be several formal balls and receptions in the evenings.

### G. C. A. TO MEET AT WHITE SULPHUR SPRINGS, OCTOBER 27-28-29

The regular fall meeting of the Glass Container Association will be held at White Sulphur Springs, October 27-28-29, according to announcement by E. G. Ackerman, Assistant Business Manager, and Victor L. Hall, Secretary.

### BUREAU OF STANDARDS SAMPLES

For the convenience of the many ceramic laboratories using the standard samples prepared by the National Bureau of Standards, the following list of ceramic and glass standards now current is given below:

| | | | Approximate weighting | Price per sample |
|---|---|---|---|---|
| | **CERAMIC MATERIALS** | | | |
| 104 | Burned magnesite | Complete analysis | 60 | $2.00 |
| 76 | Burned refractory (40% $Al_2O_3$) | do. | 60 | 2.00 |
| 77 | Burned refractory (60% $Al_2O_3$) | do. | 60 | 2.00 |
| 78 | Burned refractory (70% $Al_2O_3$) | do. | 60 | 2.00 |
| 103 | Chrome refractory | $Cr_2O_3$, $SiO_2$, $Al_2O_3$, FeO, CaO, MgO | 60 | 2.00 |
| 97 | Clay, flint | Complete analysis | 60 | 2.00 |
| 98 | Clay, plastic | do. | 60 | 2.00 |
| 70 | Feldspar, potash | do. | 40 | 2.00 |
| 99 | Feldspar, soda | do. | 40 | 2.00 |
| 79 | Fluorspar | do. | 60 | 2.50 |
| 1a | Limestone, argillaceous | do. | 50 | 2.00 |
| 88 | Limestone, dolomitic | do. | 50 | 2.00 |
| 92 | Glass, low boron | $B_2O_3$ | 45 | 2.00 |
| 93 | Glass, high boron | Complete analysis | 45 | 2.00 |
| 89 | Glass, lead-barium | do. | 45 | 2.00 |
| 91 | Glass, opal | do. | 45 | 2.00 |
| 80 | Glass, soda-lime | do. | 45 | 2.00 |
| 81 | Glass sand | $Fe_2O_3$, $Al_2O_3$, $TiO_2$, $ZrO_2$, CaO, MgO | 60 | 2.00 |
| 102 | Silica brick | Complete analysis | 60 | 2.00 |
| 112 | Silicon carbide | do. | 85 | 2.00 |
| | **FINENESS STANDARDS** | | | |
| 46r | Cement (normal) | | 160 | $1.00 |
| 47q | Cement (extra fine) | | 160 | 1.00 |
| 114b | Cement (turbidimetric standard) | | 12 | 2.00 |
| | **CHEMICALS** | | | |
| 84 | Acid potassium phthalate | Acidimetric value | 60 | $3.00 |
| 39e | Benzoic acid | Acidimetric and calorimetric values | 30 | 2.00 |
| 40c | Sodium oxalate | Oxidimetric value | 60 | 2.00 |
| 83 | Arsenic trioxide | do. | 75 | 2.00 |
| 38b | Naphthalene | Calorimetric value | 50 | 2.00 |
| 17 | Sucrose (cane-sugar) | Calorimetric and saccharimetric values | 60 | 2.00 |
| 41 | Dextrose (glucose) | Reducing value | 70 | 2.00 |

Summaries of analyses of these standard samples and other general information are given in the Supplement to Circular 398. This can be obtained free of charge upon application to the National Bureau of Standards, Washington, D. C.

# OUTLINE PLANS FOR CERAMIC ENGINEERS INSTITUTE

Formation of an Institute of Ceramic Engineers within the American Ceramic Society (see G.I. May, 1937) came a step nearer realization last month when the organizing committee prepared and distributed a circular outlining to all members of the Society the plans and purposes of the Institute. The circular was accompanied by a set of tentative membership by-laws and a questionnaire to determine the wishes of the society in the matter of final organization.

Since the annual meeting last April, speculation has been rife as to just how it would be possible for one to qualify—whether, indeed, it would be possible to establish any standard for membership that would admit more than a handful. Many society members did not secure their ceramic training during their college courses, and many ceramic engineers in the society are years away from the academic halls. Therefore, the "Information Sheet" sent out by the Organization Committee, of which John L. Carruthers is chairman, has proven of great interest to a large section of the society's membership. In Article IV the suggested membership by-laws set forth the following qualifications for membership:

Section 1. In order to be eligible, applicants for membership in the Institute must hold an engineering degree from an approved institution,* and be a member or Fellow of the American Ceramic Society in good standing.

Section 2. The grades of membership in the Institute shall be: (a) Junior Member. (b) Associate Member, and (c) Member.

Section 3. The grade of Junior Member may be held only by graduates, under 30 years of age, of a school or college of engineering. A Junior Member shall be automatically advanced to the grade of Associate Member 3 years after graduation.

Section 4. The grade of Associate Member may be held by any member of the American Ceramic Society who holds an engineering degree from an approved institution, providing 3 years' practice in engineering has been acquired since the first degree was conferred.

Section 5. The grade of Member shall be held only by those who can qualify under the "minimum definition of an engineer" as adopted by the Engineers' Council for Professional Development. The minimum definition prescribes professional education, specified experience, and the passing of written examinations.

"Professional education" is here defined as graduation from a school or college of engineering approved by the Committee on Examinations of the Institute.

"Specified experience" is here defined as 5 years in responsible charge of important work.

"Written examinations" are defined as the passing of examinations in securing a professional license under state laws or the passing or written examinations under the supervision of the Committee on Examinations of the Institute. (Note: The possession of a professional engineer's license issued by any state or national examining board shall be considered as evidence of fulfillment of this requirement.)

To make the by-laws entirely clear, it is only necessary to add the "Minimum Definition of an Engineer," adopted by the E. C. P. D. in October, 1933. These minimum qualifications are:

(a) Graduation from an approved course in engineering of four years or more in an approved school or college; a specific record of an additional four years or more of active practice in engineering work of a character satisfactory to the examining body (the examining body, at its discretion, may give credit for graduate study in counting years of active practice); and the successful passing of a written and oral examination covering technical, economic, and cultural subjects, and designed to establish the applicant's ability to be placed in responsible charge of engineering work and to render him a valuable member of society; or, alternatively,

(b) Eight years or more of active practice in engineering work of a character satisfactory to the examining body, and the passing of written and oral examinations designed to show knowledge and skill approximating that attained through graduation from an approved engineering course, and also examinations, written and oral, covering technical, economic, and cultural subjects designed to establish the applicant's ability to be placed in responsible charge of engineering work and to render him a valuable member of society.

The response of the society membership to the questionnaire has proved to be prompt and decisive. Within a few days the committee had received several hundred replies and they are still coming in. Furthermore, the replies are almost unanimously in favor of the establishment of the Institute and in approval of the tentative by-laws. The committee will proceed in a careful analysis of the questionnaire response and their recommendation of the final organization plan will be submitted.

*Approved by the Committee on Examinations of the Institute.

## GLASS DIVISION TO GREET DR. SCHULTZE

When the Glass Division holds its summer meeting at State College, Pa., September 10, it will have as guest of honor Dr. R. Schultze, technical editor of *Glastechnische Berichte*. Dr. Schultze will speak informally on the plans of the Deutsche Glastechnische Gesellschaft for the third International Congress on Glass, which will be held in Germany. He will also speak on "A Glassman's Trip Through Germany," discussing some of the German glass districts, the notable collections of glass, and also depict some of the spots of beauty and interest that are to be found on the route.

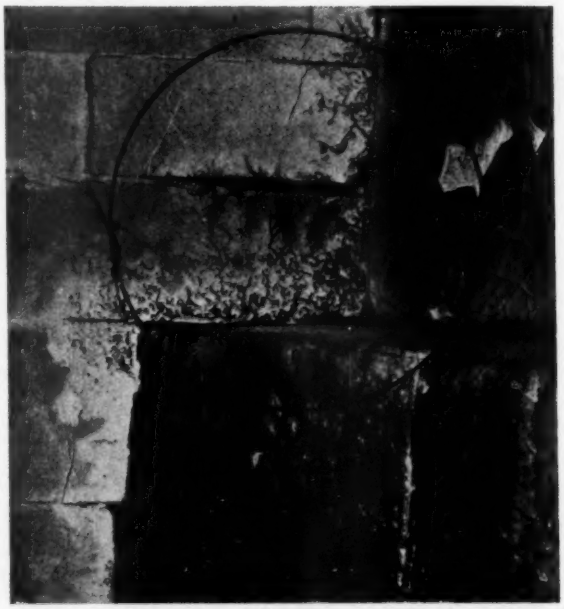
Last year, when members of the American delegation to the London conference made a side trip to Germany, Dr. Schultze acted as host and did much to add to the pleasure and interest of the visit. An opportunity is now presented to American ceramists to return his hospitality. Until he returns to Germany, on October 16, Dr. Schultze will visit centers of ceramic activity.

The Glass Division will be glad to learn that Dr. J. T. Littleton is again in good health and plans to attend the meeting.

# SLAGGING OF GLASS TANK REFRACTORIES ABOVE THE METAL LINE

Dr. Jebsen-Marwedel, in *Glastechnische Berichte* for April, 1937, presents a study of the destruction of refractories in the superstructure of tanks with special reference to the effect of contact between different kinds of bricks together with the attack of fumes and dusts.

It seems that in many furnace installations it is not enough to select specially resistant material for construction. Observation shows that it is even more important to look out for the arrangement or association of these refractory blocks in the walls. The use of more and more refractory bricks, associated with bricks of another composition such that eutectic reactions can take place at the surface of contact, more or less accompanied by batch dust or alkaline vapors, leads to destruction. Fig. 1 illustrates an all too common failure, quite familiar to many tank operators. Either one of these blocks—clay or silica—would have stood up very well alone, but at the surface of contact, there has arisen a definite infiltration or honeycombing of the silica which will eventually lead to complete failure. Fig. 2 depicts the history of this destruction. A shows the trickling of the slag which has formed into the pores; B, the broadening of the pores into canals; C, the remaining structure, a spongy body that could be crushed in the hand; D shows places where the flowing slag has come out on the vertical surface.

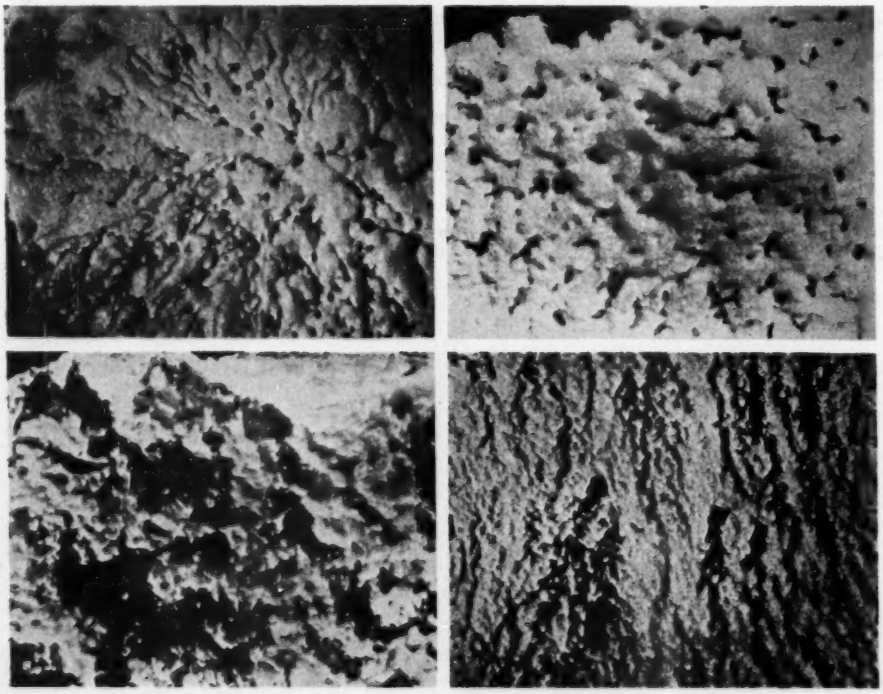


● *Fig. 1. Beginning of silica destruction by the contact of glazed clay (from a bottle tank).*

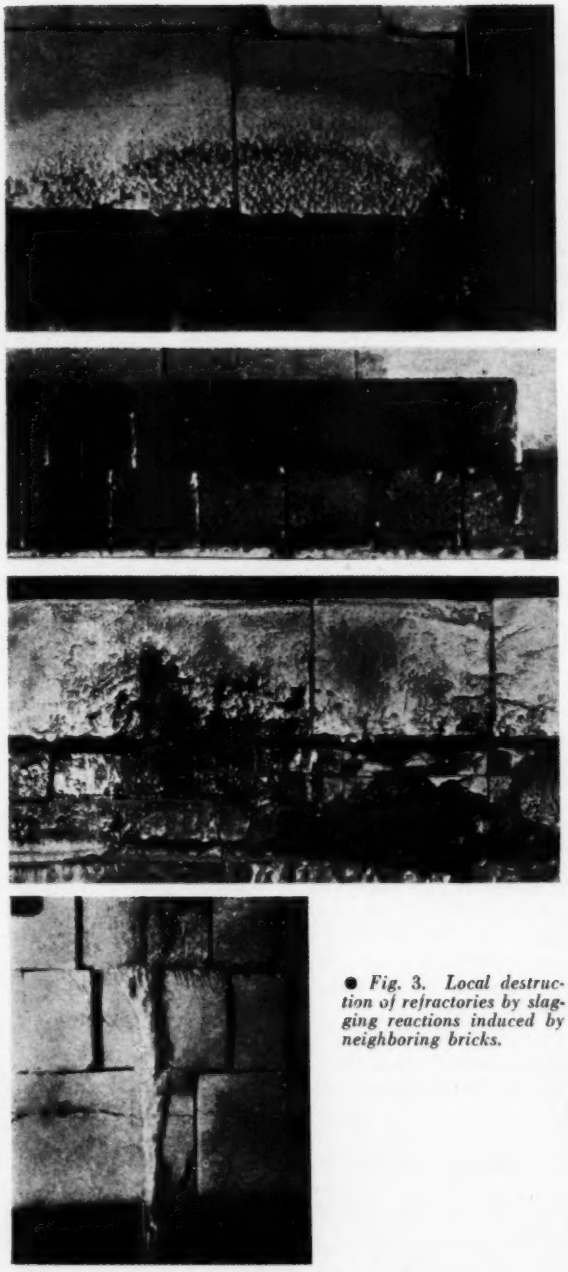
The identification of these processes is not enough to explain them, but through the study of a number of these phenomena, we can at least get certain relationships. Accordingly attention is directed to a few questions which are of general interest for furnace builders.

In Fig. 3 are shown a series of cases in which the process of local corrosion in part accompanied by softening is going on. Without exception, these phenomena take place where *dis-similar* materials are associated, or where their soluble components have managed to flow together through gravity, creeping, or with the aid of liquids formed from floating dust.

The destruction that follows is so extensive and at the same time so definite'y localized that sometimes the outer surface seems to be unaffected while the interior of the masonry is badly disintegrated. In this connection, the slagging action of material carrying iron is especially worthy of attention. Whenever iron is present in the raw materials of a refractory it is possible for fayalite ($2FeO\text{-}SiO_2$) to form, which is very easily fusible, and very fluid. Much of the corrosion of furnace blocks which carry iron may be laid to the formation of this type of slag. Eventually this slag must flow down into the glass bath, which has otherwise been jealously guarded against contamination. Many tanks which have



● *Fig. 2.*

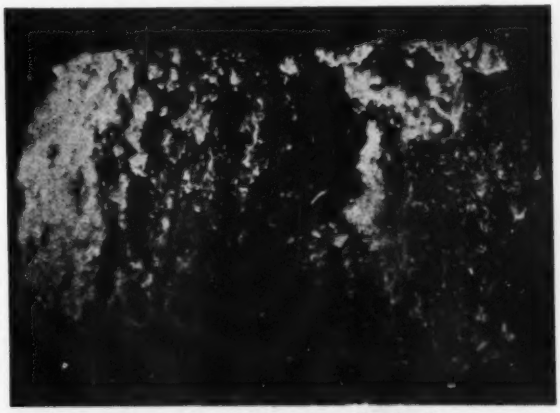


● *Fig. 3. Local destruction of refractories by slagging reactions induced by neighboring bricks.*

been let out of service show the evil effects of this travel of the slag into the product.

In Fig. 5—the most impressive picture which can be shown—liquid slags have formed, apparently through the operation of an improperly chosen mortar, and have run down into the main body of glass. The origin of the slag, as the profile on the silica wall shows, lies well above the melt. The particular maliciousness of this slag formation consists in the fact that the superstructure is gradually corroding away, and the product is running down into the glass bath—a process which is hidden from the observer's eye during the operation of the furnace, but which is a dangerous and hitherto unsuspected source of the formation of cords, whose origin may be several feet above the melt.

In Fig. 6 there is a single block whose wrong setting has led, in the usual way, to its becoming a spring of destruction. In this case it can be observed that it contained a good deal of sulphate which has caused slagging. This sulphate must have been taken up by the block as a condensate out of the atmosphere of the furnace, when it was formerly used in another place at a temperature below 1250°C. Fig. 7 shows the behavior of a high-alumina refractory whose original quality was above criticism, but whose destruction can be laid only to its association in the wall with other types of material. The chemical relationships of these refractories become very important in furnace construction. The combination of sillimanite with silica is an outstanding example of how important this association of different bricks (not their use as such) can be. The construction where silica lies *over* sillimanite may indeed cause some limited fluxing, but this is usually of a harmless sort, and because of the highly refractory character of the sillimanite, becomes of no great importance. Fig. 8 exhibits what may happen in this type of wall. However, this siliceous slag may give rise to vertical fissures in the sillimanite as shown in Fig. 9. It seems to be inadvisable from the standpoint of good furnace building technique ever to use, as an underpinning for silica wall, an alumina-rich clay block. The arrangement of sillimanite on top of silica almost invariably leads to widespread destruction in the form of flowing away and honeycombing (Fig.



● *Fig. 4. Ferrous slag eats through a silica brick.*

● *Fig. 5. Cascades of slag flowing down from the jamb wall cut through the lower blocks into the glass melt.*

● *Fig. 6.*

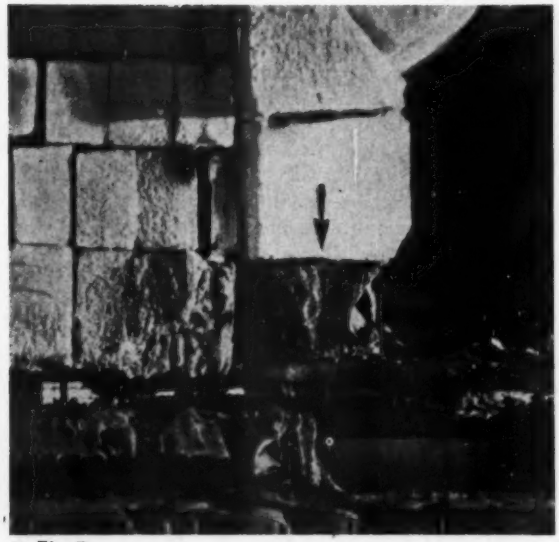
10). When a mortar is used which contains sillimanite in the building of a silica wall, the same kind of slagging may be expected (Fig. 11).

The difference between two types of setting and accordingly the fundamental behavior is shown in the three-component diagram, $SiO_2$-$Al_2O_3$-$R_2O$, of Fig. 12, whose two extremities represent the principal materials, $Al_2O_3$ and $SiO_2$. If now we imagine that the principal destructive agent being received from the batch as a flux carries the general label $R_2O$, then the third side of the diagram gives the proportion of this foreign material, that is, alkali. Other definite points represent the composition of normal silica, a clay, and sillimanite. If it is desired to predict what course of reaction may be expected if a batch dust reacts with building material in the interior of the furnace, we must look for the same kind of consequences which would result by the mixture of glass with the building material under consideration.

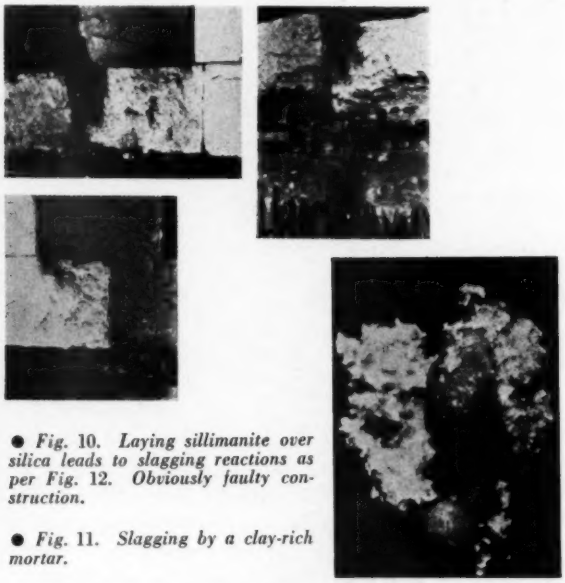
Two distinct cases will come under observation. In the first, the glaze on the interior of the furnace is siliceous and is further enriched with silica along the line of the points ooooo. Under the force of gravity it flows down upon the underlying sillimanite. The composition of the reaction mixture thus moves toward the sillimanite point corresponding to the shaded area on the diagram. The eutectic mixture demonstrated by Rice, containing about 5 per cent alumina, 17 per cent soda, and 77 per cent silica, can therefore be avoided because of the limited silica content. On the other hand, if the glaze on the block takes up as a soluble component sillimanite up to the point ooooo and then has opportunity to take up silica, the reaction mixture will reach the shaded zone.

One may thus recognize that an entirely different region of the three-component system will be traversed according to whether *silica over sillimanite*, or *sillimanite over silica*, is the arrangement in question.

It may be remarked that several of the illustrations are also used in "Glastectnische Fabrikationsfehler," by the same author.



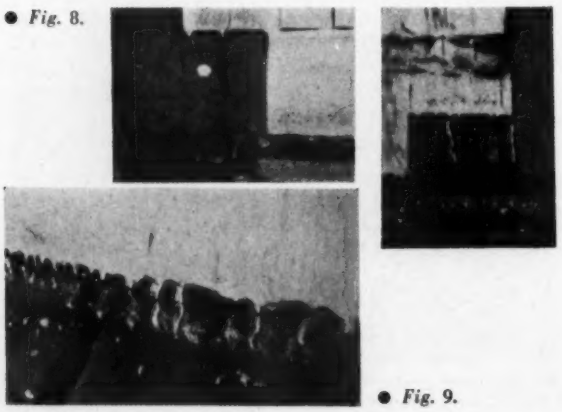
● *Fig. 7.*



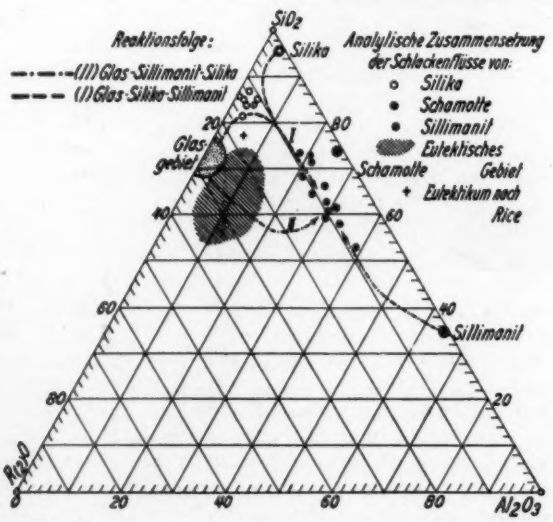
● *Fig. 10. Laying sillimanite over silica leads to slagging reactions as per Fig. 12. Obviously faulty construction.*

● *Fig. 11. Slagging by a clay-rich mortar.*

● *Fig. 8.*



● *Fig. 9.*




● *Fig. 12.*

## OPTICAL SOCIETY MEETING

The Optical Society of America will hold its annual meeting at the Lake Placid Club, Essex County, New York, October 14 to 16 inclusive. Papers will be read on the following subjects: "Optics and the Glass Industry," "The Availability of Optical Glasses," "Glass Requirements of the Optical Manufacturer," and "Crystal Growing for Optical Purposes. All meetings will be held in the morning with the afternoons left free for recreational purposes. L. B. Tuckerman, secretary of the society, has extended a cordial invitation to non-members to be present.

## FASTEST LENS IN THE WORLD

What is said to be the fastest lens in the world is reported by Dr. M. L. Humason of the Mt. Wilson Observatory staff in his tests of a new spectrographic lens designed by Dr. Wilbur B. Rayton, head of the Bausch & Lomb Scientific Bureau. The lens, which is an eight-fold enlargement of a microscope objective, is now mounted in a spectrograph at the Cassegrain focus of the 100-inch telescope at Mt. Wilson.

Since the field of view was small in comparison with those usually demanded of photographic objectives, the problem was similar to that of designing a microscope objective. Dr. Rayton designed an objective with a focal length of 32 mm and an aperture of 50 mm, or a ratio of F/o.59, approximately six and a half times faster than the fastest candid camera lens.

## GASES IN OPTICAL AND OTHER GLASSES

It is a well established fact that, when heated to a high temperature in vacuum, practically all ordinary glass evolves gases, including water vapor, carbon dioxide, and oxygen. A knowledge of the amounts and kinds of gas dissolved in some glasses has assisted manufacturers in reducing the quantity of seeds (small bubbles) in those glasses.

Although there are few, if any, seeds in the better grades of window glass and in some of the optical crown glasses (borosilicate crowns and light crowns), those containing barium (such as the light barium crowns) are usually "seedy," and it was thought that a study of the gases dissolved in the barium crowns might lead to a method for eliminating seeds.

Accordingly, the gases in samples of these glasses were determined, and it was found that the amount of water vapor in all samples was, in general, about 25 ml/100 g of glass, but the amounts of the other gases varied considerably. The gases, other than water vapor in the borosilicate and light barium crowns, never exceeded 2 ml/100 g of glass, the light crown yielded about 4 ml and the window glasses about 40 ml. The vigorous mechanical stirring incident to the manufacture of optical glass probably explains the small amount of gas found in it, as compared with that obtained from the window glasses, which are not stirred. Since the quantity of gas obtained from the "seedy" light barium crown was small and about the same or only slightly greater than that obtained from the "seedless" optical glasses, and was decidedly less than from the relatively seedless window glass, it was concluded that the gases dissolved in the light barium crown have no bearing on the prevalence of seeds in the latter.—From *Technical News Bulletin*, U. S. *Bureau of Standards*, July, 1937.

## GLASS SAND

(*Continued from page* 297)

plate glass manufacture, sand for sandpaper, and for such minor uses as enabling locomotives to get a grip upon the rails, are products produced by similar processing of quartz deposits, but requiring, of course, a less critical quality in the original rock or deposit and less careful treatment in preparation.

Although the producers of glass sand are comparatively few in number, the business remains highly competitive, and the cost of the silica in glass products remains very small in comparison with the value of the ware. The speed and efficiency of our transportation system enables any glass manufacturer to buy his sand practically wherever he desires, although, to be sure, the comparative freight rates enter strongly into his choice of source. It is true that on the West Coast, at points far distant from the inland producers, some glass factories import European sand, brought in as ship ballast; but, in general, the American product is so superior and so low in cost, that we are not concerned with foreign competition. The natural gift of magnificent quartz deposits has been well developed by the progressive sand producers, with the result that the American glass manufacturer has at his disposal a silica supply which he often takes too much for granted.

## PLATE GLASS PRODUCTION

P. A. Hughes, secretary of the Plate Glass Manufacturers of America, reports production of Polished Plate Glass for the month of June as 19,392,254 square feet. This compares with 19,437,246 sq. ft. produced in May and 16,243,665 sq. ft. in June, 1936. The total production for the six months ending June, 1937, amounts to 106,577,499 sq. ft.

Output for July totaled 15,344,855 sq. ft., which compares with 16,427,849 sq. ft. during the same month of 1936.

## CORNING'S "HOUSE OF GLASS" READY

On September 1, Corning Glass Works, Pittsburgh- Corning Corporation, Macbeth-Evans Glass Co. and Steuben Glass will combine their offices under one roof in Corning's new "House of Glass," which is now nearing completion. The ground floor will be occupied by the Steuben salon, the second floor by Pittsburgh-Corning, and the third and fourth floors jointly by the Macbeth-Evans Division of Corning and the Corning Metropolitan sales organization.

The building is unique in many particulars. Both exterior and partition walls throughout are glass block or glass tile, 4,000 blocks having been used in its construction. Fibrous glass has been used extensively; in the framework for insulation and in partitions for acoustical purposes. The building is the only example on record where nickel silver has been used as a trim, there being 3,640 lbs. in the exterior and an even greater quantity inside. The new House of Glass is air conditioned throughout, and of course has no windows.

# FLAT GLASS AND RELATED GLASS PRODUCTS

## SURVEYED BY TARIFF COMMISSION

The United States Tariff Commission has recently issued advance copies of Report No. 123, Second Series, entitled "Flat Glass and Related Glass Products." It is stated that "the primary object of the survey is to present factual data that will be helpful in future tariff action, as well as of interest to those concerned with the trade in these products. . . ." The advance mimeographed copies (500 pages) will be followed later by a printed edition.

This new report will be of considerable interest to flat glass manufacturers, mostly because it gathers in one place a great mass of industrial and governmental data which are important for the development of domestic and foreign flat glass markets, as well as for tariff consideration. Detailed figures on production prices, imports, exports, etc., are given through the year 1935, and the major developments in the flat glass industry are traced from the earliest times to the present. The sections devoted to changes and advances in technical procedure are more or less elementary, although the effects of these advances are clearly traced. This is, however, in line with the announced purpose to restrict the survey to the general manufacturing and economic phases of the flat glass industry without attempting any extensive treatment of technical problems and development.

Report No. 123 turns out to be quite readable and interesting because of the manner in which the voluminous data have been organized and treated and in spite of the exhaustive analysis of practically every phase of the flat glass industry. The material is segregated in sections corresponding to the major products in the flat glass field, such as Cylinder, Crown and Sheet Glass (Chap. II); Plate Glass (Chap. III); Rolled Glass and Wire Glass (Chap. IV); Structural or Architectural Glass (Chap. V); Safety Glass (Chap. VI). Each of these chapters follows a fairly uniform pattern, starting out with a description of the product and the tariff rates and following through with a short history of the industry, descriptions and illustrations of the manufacturing processes, production data, imports, exports, production costs, markets, transportation, prices, competitive conditions, and duties and classifications.

The report starts with a chapter devoted to a general discussion of the industry, including tariff history and history of glassmaking, raw materials, fuel, manufacturing processes, domestic production location and markets. This introductory material will appear elementary to the average glass man, but it does serve to set the stage for the lay reader and to make more understandable the later detailed discussions. Three subsequent chapters are used for an analysis of minor products, such as mirrors, stained or painted window glass, and miscellaneous glass products, such as bent and ornamented glass and mirrors. Chapter X discusses foreign production and international trade in flat glass and will be found very interesting because it considers many pertinent factors other and in addition to the usual cost and tariff figures.

The appendix section of the report contains reference data that every flat glass manufacturer will be glad to have available. The subjects include Tariff Laws; Import and Basic Price Statistics; Workers' Organizations and Collective Bargaining; Trade Practice Rules; State Laws and Regulations on Safety Glass; Foreign Tariffs; Transportation Charges to Important World Markets, and Packaging. Much of this data is taken from published data of other governmental agencies, such as the Department of Commerce, Federal Trade Commission and the Department of Labor.

It is impossible, in the space available for this review, to give even the high spots of this report, on account of the enormous amount of facts, detailed analyses and statistics that it incorporates. Of special interest, however, are the discussions of the broad effects of mechanization on the economics of the industry; the development of the enormous market for plate, sheet and safety glass in the automobile industry; corporate developments and changes among U. S. producers; and the steadily decreasing importance of imports from foreign producers as a factor in the domestic market.

The report shows that in 1935 seven companies were manufacturing laminated glass, but not all were glass producers. It is stated that "the development of the laminated glass industry, particularly in the United States, is one of the most important advances of the last decade in the entire field of glass manufacturing." The statement is supported by figures on the value of production during recent years. In 1931 the production of laminated glass was 10,000,000 sq. ft., having a value of $9,000,000. By 1933 production had risen to 18,000,000 sq. ft., worth $15,000,000, but in 1935 the industry produced $53,000,000 worth of laminated glass, or a total of over 70,000,000 sq. ft.

Of particular interest, as far as new product developments are concerned, are tempered safety glass and structural glass block. These products are so new that their competitive effect in the industry cannot yet be ascertained, and their production is not yet much of a factor. Tempered safety glass may, if its advantages are proved, become more widely used in the automobile trade, and it is now being manufactured by two large companies in the United States. Glass blocks are still hardly out of the experimental stage, but three U. S. companies are now manufacturing these products.

The publication of this report brings the Tariff Commission data on the flat glass industry up to date in every respect, and the compilers of the report are to be congratulated on the results of their research and the careful organization and presentation of the voluminous material. The book is a distinct contribution to the literature on glass manufacture and will be read with interest and profit by every member of the flat glass industry.

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Window glass production was 1,302,406 boxes during the month of July which represents 81.3 per cent of the industry capacity. The total production for seven months of 1937 amounted to 7,789,062 boxes which represents 68.5 per cent of industry capacity.

# EQUIPMENT AND SUPPLIES

## CATALOGS RECEIVED

*Lancaster Mixers.* Bulletin 70-B of Lancaster Iron Works, Inc., Lancaster, Pa. A 50 page catalog, profusely illustrated, describing the various types and sizes of this machine, its adaptation to the various industries, the principle of mixing involved, construction details, etc.

*Universal Camera-Microscope MeF.* C. Reichert, Vienna, Austria. Pfaltz & Bauer, Inc., New York, agents. Technical description and data, including prices, of this apparatus, which combines several instruments into one universal camera-microscope to enable every possible method of microscopic examination to be performed in transmitted or incident, ordinary or polarized light.

*The Stacker and Portable Elevator.* Lewis Shepard Company, Watertown, Mass. A colored folder showing the uses and types of stackers, tiering machines, and Portable Elevators manufactured by this company.

*Bulletin* 6205. Fairbanks, Morse & Co., Chicago. Describing both general and low service duplex steam pumps, designed to pump water, oil and similar liquids at pressures up to 420 lbs. per sq. in. in quantities up to 464 gal. per minute.

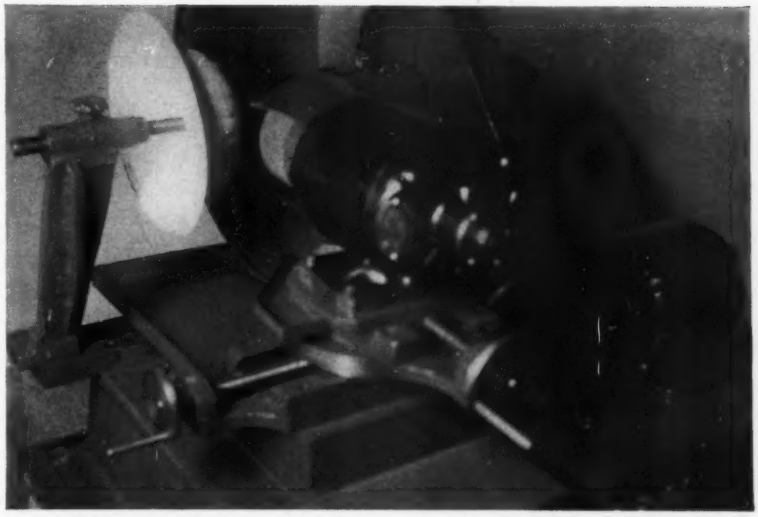
## LARGEST MAGNETIC SEPARATOR

The Stearns Magnetic Mfg. Co., Milwaukee, manufacturers of magnetic separation equipment, has recently shipped one of the largest of its Type "K" magnetic separators that has ever been built. This machine is a 90" three field gravity induction type separator. It has been shipped to an Eastern silica sand producer supplying local glass factories for use in purifying this sand from iron particles.

## TRAVELING BATCH MIXERS

Type of traveling batch mixers now being shipped from the United States to Soviet glass factories. The unit consists of a chassis, revolving mixer and scales. When loading, an indicator on the dial of the scale is set at a predetermined position (there are eight indicators on the unit illustrated), to show the amount needed of each of the batch materials. When loading is completed, the gate of the mixer is closed and the entire unit is moved (electrically driven) to the melting furnace, the drum meanwhile revolving. In the melting chamber the gate is opened and the mixer discharges after a few revolutions. Stephens-Adamson Mfg. Co. manufactured the unit, which is equipped with Fairbanks Scales.

● *Traveling batch weighing and mixing car with Fairbanks pipe lever scale.*

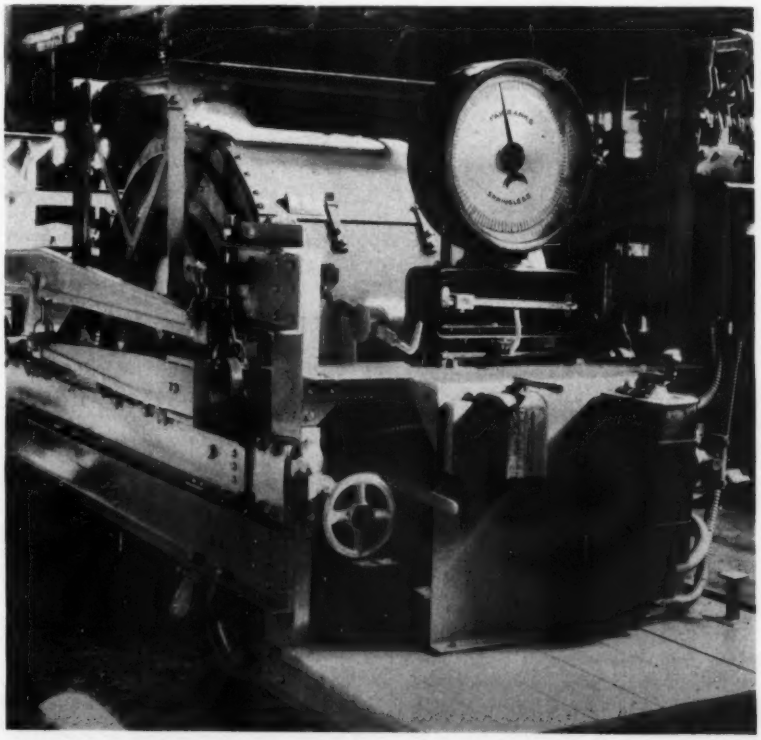


● *Samuel C. Rogers & Company's new circular knife grinder.*

## CIRCULAR KNIFE GRINDER

A new type of Circular Knife Grinder, illustrated here, has just been put on the market by Samuel C. Rogers & Co., Buffalo. Built in three sizes, for knives from one to 20 inches in diameter, the grinder will take any type of circular knife, single or double bevel, and return it to its original trueness and sharpness.

The knife is mounted on an adjustable arbor. The grinding wheel is mounted directly on the arbor of the ball bearing motor which has provision for eliminating end thrust. This latter assembly by means of triple slides and swivel, permits adjustments to meet all requirements of circular grinding, whether single or double bevels of any degree. The swivel is graduated to insure correct bevel angle setting. Adjustable steel gibs take up wear. The machine is entirely self-contained, with control switches conveniently mounted on base.



# CURRENT PRICES OF GLASS-MAKING MATERIALS

**FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS**

## Base Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh | ton | 42.00 | 45.00 |
| Barium sulphate, in bags | ton | 19.00 | 24.00 |
| Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point | ton | 15.00-16.00 | 18.00 |
| Borax ($Na_2B_4O_710H_2O$) | lb. | .... | .... |
| Granulated | In bags, lb. | .021 | .0255-.028 |
| Powdered | In bags, lb. | .0235 | .028-.0305 |
| Boric acid ($H_3BO_3$) granulated | In bags, lb. | .0475 | .0525-.055 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | lb. | .07 | .07½ |
| Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith) | lb. | .08½ | .09 |
| Synthetic (Artificial) | lb. | .08½ | .09 |
| Feldspar— | | | |
| 20 mesh | ton | 11.00-13.25 | |
| 40 mesh | ton | 11.50-13.75 | |
| Granular | ton | 11.75-14.00 | |
| Semi-granular | ton | 11.00-13.25 | |
| L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags | | | |
| Fluorspar ($CaF_2$) domestic, ground, 96-98% (max $SiO_2$, 2½%) | | | |
| Bulk, carloads, f. o. b. mines | ton | 31.50 | .... |
| In bags | ton | 33.10 | 38.00-40.60 |
| Kryolith (see Cryolite) | | | |
| Lead Oxide ($Pb_3O_4$) (red lead) (N. Y.) | lb. | .09 | .... |
| In 5 Ton lots | lb. | .095 | .095 |
| Less than 5 Tons | lb. | .10 | .10 |
| Lime— | | | |
| Hydrated ($Ca(OH)_2$) (in paper sacks) | ton | 10.50 | .... |
| Burnt (CaO) ground, in bulk | ton | 7.00 | .... |
| Burnt, ground, in paper sacks | ton | 9.00 | .... |
| Burnt, ground, in 280 lb. bbls. | Per bbl. | 2.25 | 2.25 |
| Potassium carbonate— | | | |
| Calcined ($K_2CO_3$) 96-98% | lb. | .065-.0675 | .07¾ |
| Hydrated 80-85% | lb. | .055 | .0575 |
| Salt cake, glassmakers ($Na_2SO_4$) | ton | 18.00 | 27.00 |
| Soda ash ($Na_2CO_3$) dense, 58%— | | | |
| Bulk | Flat Per 100 lb | 95 | .... |
| In barrels | Per 100 lb. | 1.35 | .... |
| In bags | Per 100 lb. | 1.10 | .... |
| Sodium nitrate ($NaNO_3$)— | | | |
| Refined (gran.) in bbls. | Per 100 lb. | .... | 2.25-2.65 |
| 95% and 97% | | | |
| Bulk | Per 100 lb. | 1.35 | .... |
| 200 lb. bags | | 1.415 | 1.44 |
| 100 lb. bags | | 1.45 | 1.475 |

## Special Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Aluminum hydrate ($Al(OH)_3$) | lb. | .... | .03½ |
| Aluminum oxide ($Al_2O_3$) | lb. | .04 | .05 |
| Antimony oxide ($Sb_2O_3$) | lb. | .15 | .15½ |
| Arsenic trioxide ($As_2O_3$) (dense white) 99% | lb. | .03 | .03¾ |
| Barium nitrate ($Ba(NO_3)_2$) | lb. | .... | .07¼ |
| Rutile ($TiO_2$) powdered, 95% | lb. | .11-.12 | .13-.15 |
| Sodium fluosilicate ($Na_2SiF_6$) | lb. | .06¼ | .66½ |
| Tin Oxide ($SnO_2$) in bbls. | lb. | .... | .60 |
| Zinc Oxide (ZnO) | | | |
| American process, Bags | lb. | .06¼ | .06½ |
| White Seal, 150 lb. bbls. | lb. | .08¾ | .09 |
| Green Seal bags | lb. | .08 | .08¼ |
| Domestic White Seal bags | lb. | .08½ | .08¾ |
| Red Seal, bags | lb. | .07½ | .07¾ |
| Zircon | | | |
| Refined Granular (Milled .005-.02c higher) | | .07 | .07½-.08 |
| Commercial, Gran. (Milled .005-.02c higher) | | .03 | .04-.05 |

## Coloring Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Barium selenite ($BaSeO_3$) | lb. | .... | 1.50-1.75 |
| (Commercial, 25% Selenium) | lb. | .... | .90 |
| Cadmium sulphide (CdS) | lb. | .... | 1.50-155 |
| Chromite | lb. | .... | .0215 |
| Cerium hydrate | | | |
| 100 lb. drums and 600 lb. barrels | lb. | .... | .60 |
| Chrome Oxide Green, 400 lb. bbls. | lb. | .... | .21-.26 |
| Cobalt oxide ($Co_2O_3$) | | | |
| In bbls. | lb. | .... | 1.67 |
| In 10 lb. tins | lb. | .... | 1.77 |
| Copper oxide | | | |
| Red ($Cu_2O$) | lb. | .... | .20¼ |
| Black (CuO) | lb. | .... | .18½-20¼ |
| Black prepared | lb. | .... | .22 |
| Iron Oxide— | | | |
| Red ($Fe_2O_3$) | lb. | .... | .0425 |
| Black ($Fe_3O_4$) | lb. | .04½ | .... |
| Iron Chromate | lb. | .... | .035-.05 |
| Lead Chromate ($PbCrO_4$) | lb. | .... | .16 |
| Manganese, Black Oxide | | | |
| In Paper bags | ton | 55.00 | 58.00-63.00 |
| In Burlap bags | ton | 57.00 | 60.00-65.00 |
| In Casks | ton | 59.00 | 63.00-67.00 |
| Neodymium oxalate, 50 lb. drums | lb. | .... | 3.50 |
| Nickel oxide ($Ni_2O_3$), black | lb. | .... | .35-.40 |
| Nickel monoxide (NiO), green | lb. | .... | .35-.40 |
| Potassium bichromate ($K_2Cr_2O_7$)— | | | |
| Crystals | lb. | .... | .09 |
| Powdered | lb. | .... | .09½ |
| Potassium Chromate ($K_2CrO_4$) 100 lb. kegs | lb. | .... | .27 |
| Powder blue | lb. | .... | .18¾-.19¾ |
| Rare earth hydrate | | | |
| 100 lb. drums | lb. | .... | .35 |
| 325 lb. barrels | lb. | .... | .30 |
| Selenium (Se) In 100 lb. lots | lb. | .... | 2.00 |
| In lesser quantities | lb. | .... | 2.10 |
| Sodium bichromate ($Na_2Cr_2O_7$) | lb. | .06½ | .07 |
| Sodium chromate ($Na_2CrO_4$) Anhydrous | lb. | .... | .08⅜ |
| Sodium selenite ($Na_2SeO_3$) | lb. | .... | 1.80-2.00 |
| Sodium uranate ($Na_2UO_4$) Orange | lb. | .... | 1.50-1.55 |
| Yellow | lb. | .... | 1.50-1.55 |
| Sodium uranyl carbonate | lb. | .... | .80-.90 |
| Sulphur (S)— | | | |
| Flowers, in bbls. | Per 100 lb. | 3.35 | 3.70-4.10 |
| Flowers, in bags | Per 100 lb. | 3.00 | 3.35-3.75 |
| Flour, heavy, in 250 lb. bbls. | Per 100 lb. | 2.90 | 3.25-3.65 |
| Uranium oxide ($UO_2$) (black, 96% $U_3O_8$) 100 lb. lots. Black | lb. | .... | 2.25 |
| Yellow orange | lb. | .... | 1.50 |

## Polishing Materials

| | | Carlots | Less Carlots |
|---|---|---|---|
| Emery, Turkish | lb. | .... | .07 |
| Pumice Stone, | | | |
| American Ground Italian FFF, FF, F | lb. | .... | .03 |
| 0, 0½, ½, 1. | lb. | .... | .03¾ |
| Putty Powder | lb. | .... | .38-.42 |
| Rotten Stone | lb. | .... | .03 |
| Rouge, Red | lb. | .... | .14 |
| Black | lb. | .... | .16 |

# Book Reviews

## GLASS TANK FURNACES

A few months ago there appeared in Belgium "Le Four à Bassin," by Devillers and Vaérewyck. Hailed by American reviewers as one of the best works on tank furnaces published in any language for many years, the wish was expressed that something comparable was available in the English language.

Le Four à Bassin has now been translated by Samuel R. Scholes of the New York State College of Ceramics and will be published by THE GLASS INDUSTRY in late September under the title "Glass Tank Furnaces." All of the drawings and illustrations in the original book are reproduced in the American Edition. Figures and calculations have been converted into English units. In addition, Dr. Scholes has added material bringing out essential features of American practice, where the latter differs from European methods of construction and operation.

Glass Tank Furnaces will constitute the first extended publication in English dealing with the fundamental melting units for glass manufacture. It will prove a most useful reference work and source of information for all who are interested in glass, and particularly so to the plant operator.

## "EXPERIMENTAL RESEARCHES AND REPORTS, 1936"

The annual book of collected research papers, original articles, and reviews of the literature, edited by Professor W. E. S. Turner, and published by The Department of Glass Technology at the University of Sheffield, is always eagerly anticipated and welcomed by American glass technologists. Most of the research papers, to be sure, have previously appeared in the *Journal of the Society of Glass Technology* or elsewhwere; but nevertheless their assembly within these pages makes for convenience of reference.

The present volume opens with a brief report by Prof. Turner of his visit to Dr. Ctyroky at his new Institute of Glass Research in Czechoslovakia. This is illustrated with some excellent photographs giving an impression of the equipment of the institute and type of work carried on. Also by Dr. Turner, the memorial lecture on Otto Schott and his work is not only a fine tribute to this great figure in the glass industry, but it is a source of real information and inspiration to all workers in the field.

A number of papers presented at the International Congress last year are reprinted. Comment on these is unnecessary other than to say that they are British contributions and that they are selected as among the most important ones presented.

Among the reviews, thirty pages are given to a very fine report on glass by Prof. Turner and Dr. Eric Preston, as presented to the Society of Chemical Industry. Other summaries of the literature of glass published during 1936 included *Fuels and Furnaces*, by N. A. Nichols; *Refractory Materials*, by Dr. Eric Preston; *Mechanical Methods*, by M. Parkin; *Chemical Analysis*, by Miss Violet Dimbleby; and *Physical Properties of Glass*, by Dr. E. Seddon. Taken together, these amount to a well-rounded bibliography of the important material published on glass in 1936, together with complete references to original sources.

Representing a part of Dr. Turner's many readers, we gratefully acknowledge this fine collection of printed tools for the glass researcher. S. R. S.

## NEW BELGIAN GLASS TEXTBOOK

*Cours de Physico-Chimie du Verre*, by P. Gilard. This new Belgian book on the physics and chemistry of glass is something a little different in the way of text books on glass technology. It follows to some appreciable extent the pattern set by Bernard Long in his *Proprietes Physiques et Fusion du Verre*, but deals at much greater length with the Physical Chemistry of Glass Systems, and much less with the properties of clays and refractories. It has more than a trace of Peddle's *Defects in Glass* in its ancestry, but much less than Jebsen Marwedel's recent *Glastechnische Fabrikationsfeller*. Like most of the recent works on glass technology, it makes no attempt to describe processes of manufacture or manufacturing apparatus. Within the field thus delimited, the work is distinctive, and a definite addition to the literature of glass technology.

After the introductory chapter explaining that the business of glassmaking has been passing from a craft to a science, the sequence of the author's thought and his divisions of the book are as follows:

First, a section devoted to a consideration of the various States of Matter, with a view to classifying glass among these states. Then a discussion at some length of the nature of viscosity and its determining effect on the states that glass can assume and its role in manufacturing processes. This second chapter is a little bit in the nature of an interruption of the line of thought, but in a sense the initial line of thought is not resumed till the last chapter, on the Constitution of Glass, and the intermediate chapters wander over many fields, not uselessly or purposelessly, before the main road is reached again.

For a while the text lapses into the conventional discourses on the component oxides of glass (including their sources in raw materials) and on the processes of fusion. The latter chapter however is treated more scientifically in some ways than in other books in the French and English languages.

Warming up to the scientific approach, the author gives us in Chapter VI a somewhat extensive treatment of the fundamentals of physical chemistry so far, particularly, as they relate to phase equilibria. This treatment is at first general for systems of one, two, and three components, and concludes with a section on the systems of particular interest to glass technologists. It is followed by a closely related chapter on devitrification.

The tradition of Peddle and Jebsen Marwedel now makes itself felt and we get a discourse on the common defects of glass—bubbles, cords and stones—with a brief interruption to discuss thermal currents in glass tanks and their bearing on these imperfections.

The process of annealing is next discussed somewhat briefly, from a scientific point of view; i.e., as a physical process rather than an industrial procedure.

A sequence of chapters now reverts to the older tradition and discusses the physical and chemical properties of glasses (other than viscosity) and methods of producing color in glass or of eliminating color, and of producing opals. Finally, as mentioned before, there is a sudden reversion to scientific speculation on the constitution of glass.

Throughout the book we find an oscillation between an attempt to treat the subject scientifically and the necessity, in any well-balanced course of glass technology, of giving some space to a great deal of disconnected matter, partly empirical, partly rational, but too important industrially to be omitted. On the whole the author has managed very well in striking a balance, and wherever industrial matters of consequence can be tied in, even loosely, with well-established scientific principles, the attempt has been made to point out the connection.

A more peculiar circumstance is the author's insistance from page 21 onwards that all crystals are anisotropic, and glass isotropic. The existence of isotropic crys als is not mentioned, so far as the reviewer can see, and this class of crystals is one of the most numerous and most important, if not in glass technology, at least in the more general field. The treatment of the macroscopic and optical properties of crystals seems in fact more than a little confused.

Apart from a few matters of this sort, the book represents an advance in the treatment of the fundamentals of glass technology and, let us hope, foreshadows the time when the whole subject can be treated logically from start to finish in scientific terms. F. W. P.


BINNEY

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